Pediatric Crohn's Disease

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Abstract

The incidence of Crohn's disease in the pediatric population is increasing. While pediatric patients with Crohn's disease exhibit many of the characteristics of older patients, there are important differences in the clinical presentation and course of disease that can impact the clinical decisions made during treatment. The majority of children are diagnosed in the early teen years, but subgroups of very early onset and infantile Crohn's present much earlier and have a unique clinical course. Treatment paradigms follow the traditional laddered approach, but growth and development represent special considerations that must be given to pediatric-specific complications of the treatment and disease. Surgical intervention is an important component of Crohn's management and is often employed to allow improved nutritional intake or decrease reliance on medical treatments that compromise growth.

Keywords
- pediatric
- Crohn's disease
- nutritional therapy
- surgery

Crohn's disease in children is characterized by the same chronic inflammatory process in the bowel as in adults, but there are important differences in the presentation, medical treatment, and surgical therapy of the pediatric patient. Consideration of the treatment priorities and outcomes can have a significant impact on the approach to the pediatric patient. While in all patients, the objective is to induce and maintain remission of the disease, special consideration must be given to the impact of the disease and various treatments on growth and development in the pediatric patient.

The incidence of Crohn's disease in children is increasing with an incidence of 2.5 to 11.4 per 100,000 and a prevalence of 58 per 100,000.[1,2] Approximately 20 to 25% of patients who present with inflammatory bowel disease (IBD) are children younger than 18 years and 80% are in adolescence. With the increase in pediatric disease, the incidence of hospitalization and intestinal resection are also increasing in the pediatric population.[3]

Two subsets of early onset patients have been described that exhibit a more aggressive phenotype: very early onset patients who are younger than 6 years, and infantile onset patients who are younger than 2 years. In these patients, the disease is more commonly colonic and is resistant to standard therapy. The genetic and immunological basis for the process requires a directed work-up and consideration of alternative therapies to the standard adult phenotype.[4]

Adolescent onset Crohn's disease follows a more typical adult course with regard to progression to fistulizing or stricturing disease. However, the timing of onset relative to the important stage of development has implications for disease management. Because of the early onset, the risk of undergoing a surgical resection by the age of 30 years is far higher in the pediatric population (48 ± 5 vs. 14 ± 2% in adults).[5]

Presentation and Work-up

Abdominal pain is the most common presenting symptom for pediatric Crohn's disease occurring in nearly half of all new patients. Bowel symptoms and nutritional issues are common. The presenting symptoms in older pediatric patients and early onset patients are shown in ►**Table 1**.[6] Impaired growth and development is a common challenge that distinguishes pediatric from adult disease.[7] Laboratory studies typically reveal an elevated sedimentation rate, anemia, and thrombocytosis. Hypoalbuminemia is present in more than half of patients.

The diagnostic work-up includes assessment of the entire gastrointestinal (GI) tract with upper and lower endoscopy and investigation of the small bowel with upper GI/small bowel follow-through, magnetic resonance (MR) or computed tomography (CT) enterography, or capsule endoscopy in larger patients. MR enterography has been used to provide

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Table 1 Prevalence of symptoms in early and older onset pediatric Crohn's Disease[6]

Symptom	Age: 0–5 y (%)	Age: 6–17 y (%)
Abdominal pain	25	44
Weight loss	8	23
Rectal bleeding	33	21
Fever	7	14
Perianal disease	3	8
Joint pain	3	7
Nausea	3	6
Fatigue	6	9
Diarrhea	36	39
Poor growth	9	7
Vomiting	7	7

a more complete assessment of the entire GI tract.[8] Some recent evidence suggests that CT enterography may provide superior imaging,[9] but the differences are not dramatic, and the experience of the radiologist is probably more important when deciding between the two studies. Whichever method is chosen, enterography offers the advantage of cross-sectional imaging of the entire bowel wall in contrast to luminal studies such as contrast studies or endoscopy, allowing for more accurate determination of the extent of disease. The Crohn's diagnosis is based on the distribution of disease and histological findings.

The distribution of disease in the pediatric patients has been examined in a large cohort of European children. In that study, combined ileocolonic disease was found in 53% of patients followed by isolated colonic disease in 27% and limited cecal disease in 16%. The disease distribution is shown in ►**Fig. 1**.[10]

Several factors have been proposed as indicators of a potential poor outcome, including failure to respond to induction therapy, growth failure, extensive disease, and fistulas or structuring disease at presentation.

Medical Treatment

As with adult onset Crohn's disease, the treatment paradigm generally involves an escalating approach from nutritional interventions to pharmaceuticals including anti-inflammatory agents, immunosuppressive medications, and biologics. However, there is also a school of thought that in some cases, a more aggressive approach using biologics early is indicated.[11,12] The rationale for this approach is based on the evidence in adults that achieving complete mucosal healing can impact the natural history of the disease. Surgical interventions are reserved for treating complications including fistulas, strictures, and abscesses, as well as patients who fail to respond to medical treatment.

A comprehensive review of medical therapy for Crohn's disease is beyond the scope of this chapter, but general principles and guidelines from consensus group opinions will be presented.

Nutritional Therapy

Exclusive enteral nutrition (EEN) is advocated as the first line of treatment by the European Crohn's and Colitis Organization (ECCO)/European Society of Pediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) consensus guidelines published in 2014.[13] The recommendations from European studies suggests that effective treatment requires 100% enteral feedings. However, some evidence suggests that 80 to 90% enteral feedings may be effective as well, which allows the patient to continue with some intake of a regular diet.[14] Numerous studies used in establishing the ESPGHAN guidelines suggest that as many as 75 to 80% of patients respond to initial

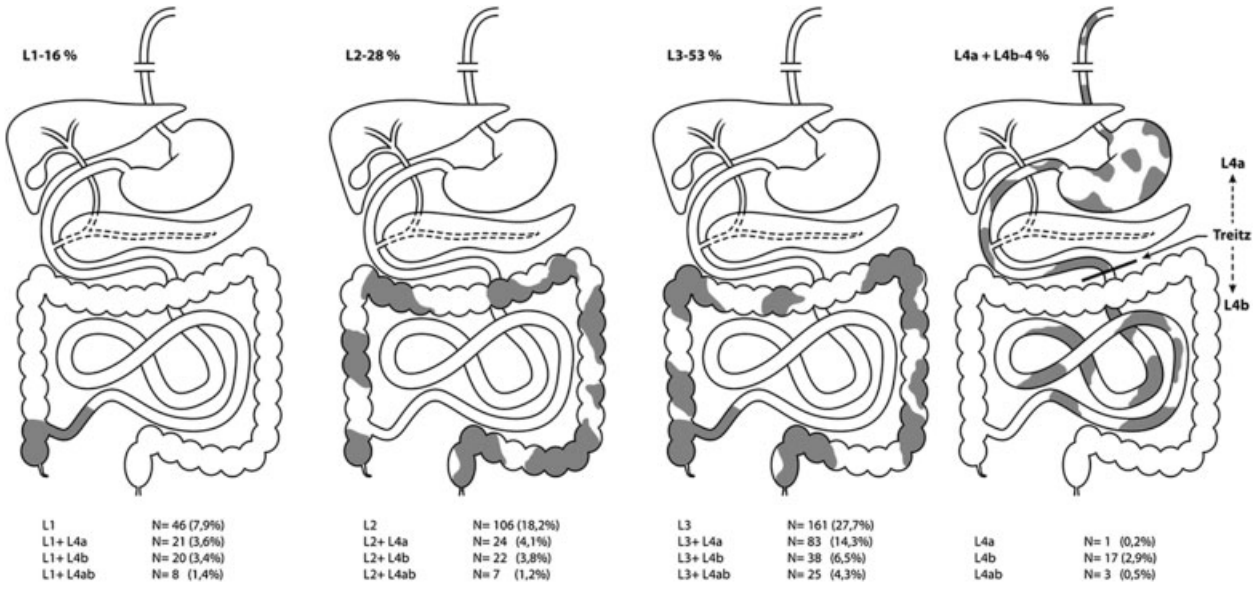

Fig. 1 Distribution of pediatric Crohn's disease.[10]

treatment with EEN and that the treatment is equivalent to treatment with corticosteroids. Failure to respond within 2 weeks is an indication to proceed with alternative therapies.

Corticosteroids and Thiopurines

Steroids have always been a mainstay in the treatment of IBD. They are recommended for patients who are not candidates for EEN or fail initial management. Steroids are dosed at 1 to 1.5 mg/kg of prednisone and are tapered over 8 to 12 weeks. Response rates are similar to EEN at 60 to 80%.[15] The disease phenotype and location are not factors in response to corticosteroid therapy, and clinical response does not correlate with mucosal healing. Unfortunately, the side-effect profile of steroids has particular risk to pediatric patients as they can have significant impact on growth. Minimizing or avoiding steroids for long-term management is a priority for many gastroenterologists. The adverse effects of steroids on wound healing bring added risk to surgical interventions in patients who fail medical management. Thiopurines and methotrexate are often used for maintenance therapy to reduce reliance on steroids.

Thiopurines require several weeks to take effect and are not used for induction therapy. They are effective in maintaining remission[15] but carry significant immunosuppressive side effects, hepatic toxicity, and pancreatitis as risks for long-term management. Methotrexate is effective but can be associated with myelosuppression, nausea, vomiting, and liver disease.[16]

Biologics

Antitumor necrosis factor (TNF) therapy has evolved as an effective treatment for induction and maintenance of remission of disease in steroid refractory disease. Infliximab (IFX) and adalimumab are both effective treatments and require induction as well as regularly scheduled dosing. The efficacy of IFX in children has been well documented.[17] As noted previously, the timing of implementing biologics during the course of disease continues to evolve, but in the absence of a specific complication requiring surgical management, biologics are now almost universally used prior to surgical treatment of the primary disease. The degree to which preoperative use of biologics increases the risks associated with an operation remains unclear.[18,19] While some studies suggest no increase in surgical risk regardless of the timing of preoperative anti-TNF infusions,[20] others have demonstrated a significant increase in complications for Crohn's patients with elevated circulating antibody levels at the time of surgery.[21]

Operative Indications

The indications for surgical intervention in Crohn's disease are varied and occur at many different stages of the disease process in children. The principles regarding surgical intervention are similar in the pediatric population, with the caveat that 50% of patients undergoing an operative intervention will require additional surgery in the future. Thus, strategies to preserve intestinal length and minimize scarring including intra-abdominal adhesions are important considerations. The goal of any operation is to control one of the many mechanical complications or resect refractory disease while minimizing long-term sequelae. By the nature of the disease, surgery is not a curative procedure, although the impact on quality of life and disease manifestations can be dramatic.

There are many clinical situations that warrant consideration of a surgical procedure during the course of a child's disease. The timing of operative intervention and the operative procedure performed vary considerably based on the segment of intestine involved and the specific complication being addressed. Isolated Crohn's disease of the foregut is relatively rare[22] and rarely requires surgical intervention. In contrast, terminal ileal and colonic diseases account for the vast majority of bowel resections in the pediatric patient. True surgical emergencies are uncommon, and most procedures are more elective in nature. The most common complications leading to a surgical intervention are obstruction, abscess, fistulas, and failure or intolerance of pharmacological treatment.[23–25]

The medical treatments for Crohn's disease have become more effective with the advent of aggressive early therapy and the addition of biologics to the armamentarium. As treatments have evolved, the indications for surgery have changed. A study of surgical indications during two consecutive time periods found that active disease decreased from 64 to 25% and chronic stricture increased from 9 to 50% as indications for operation when comparing procedures performed between 1970 and 1990 to those performed between 1991 and 1997. In addition, the time from diagnosis to initial operation increased from 3.5 to 11.5 years.[26] This data suggest that the improvements in medical treatments have altered the course of the disease but not the ultimate need for surgical intervention.

Absolute indications for surgery are rare and include free intestinal perforation, complete obstruction, and peritonitis. Many patients present with multiple relative indications rather than an acute precipitating event. In a large cohort of adults with Crohn's disease, the decision to proceed with surgery was distributed as follows: failure of medical management in 220, obstruction in 94, intestinal fistula in 68, mass in 56, abdominal abscess in 33, hemorrhage in 7, and peritonitis in 9.[27]

In the pediatric population, relative indications for surgery predominate and include some considerations that differ from those in adults. Medical therapy for Crohn's disease can have devastating side effects, and many of these adverse consequences can be greatly reduced by treating segmental areas of disease surgically, allowing reduction or discontinuation of the offending agent. While all of the medications used to treat Crohn's disease have side effects, steroid therapy is the most common culprit for causing problems in children. Growth failure, osteoporosis, psychological/emotional alterations, and body habitus changes can all prove intolerable.

As our understanding of IBD has increased, it has become clear that there are different variants of Crohn's disease, and some phenotypes are more likely to develop complications that may require operative intervention. Studies of the genotype–phenotype relationship indicate that patients with disease characterized by specific *Nod2*/*CARD15* gene mutations are particularly prone to the development of intestinal strictures[28] and may require surgical intervention

more often and earlier in the course of their disease. Conversely, a study of 146 Israeli patients identified only gender (male) and history of smoking as risk factors for complicated disease defined as the presence of structuring disease, penetrating disease, perianal manifestations, or the need for surgery. Genetic factors did not correlate with the development of complicated disease.[29] As our understanding of the relationship between genotype and phenotype grows in the future, it may be possible to target specific patient populations for specific types of surgical intervention based on response rates and specific disease characteristics.

The surgeon treating children must appreciate the impact of the issue of growth and development in that patient population.[30] In as many as 50% of pediatric patients, the indication for surgery may be a failure of medical therapy with growth retardation rather than obstruction or other mechanical complication.[31] In one study of children who had received extensive medical and or nutritional treatment before surgery, 26 patients underwent intestinal resections. The indication for surgery was chronic intestinal obstruction in 13 cases and chronic intestinal disability leading to growth failure in 13 cases.[32] Furthermore, the timing of surgery for growth issues is critical in the adolescent. Surgical intervention must occur well before epiphyseal plates close to allow sufficient time for subsequent catch up growth following the operation.[33] Surgical therapy is associated with significant catchup growth in the 6 months following operation in patients with treatment-resistant disease.[34]

Surgical Therapy

The decision to proceed to surgery in a pediatric Crohn's patient requires careful collaborative considerations by the entire treatment team caring for the child. Consultation between the surgeon and the gastroenterologist with input from radiology and pathology should inform the discussion with the patient and his/her family. True emergencies are rare, and there is usually ample time for exhausting all of the medical options before committing to an operation. If anything, reluctance to proceed to the operating room by the patient, the family, or the gastroenterologist can delay potentially effective interventions.

The surgical approach is dictated by the indication for surgery and the distribution of the disease. Procedures for progression or persistence of disease despite maximal medical therapy, intestinal strictures with evidence of partial obstruction as indicated by dilation of more proximal bowel, or complications of the medical therapy are designed to remove involved bowel. Enteroenteric fistulas may be subtle and may not precipitate an operation, but enterovesicle fistulas presenting with pneumaturia or recurrent urinary tract infections is an indication for laparotomy with resection of diseased bowel, takedown of fistula tracts, and repair of involved structures. Intra-abdominal abscesses are typically approached with percutaneous drainage, antibiotics, and aggressive treatment of the Crohn's disease prior to surgery.

The presence of a stricture alone is not an indication for operation. Areas of diseased bowel that do not present a mechanical impediment to the flow of the intestinal contents do not require intervention. However, significant chronic obstruction is suggested by dilation of bowel loops proximal to the diseased area, signifying a possible impending complete obstruction. Typically, a primary resection of the diseased segment of bowel with a primary anastomosis is possible, avoiding the need for a diverting ileostomy. In pediatric patients with stricturing disease, the terminal ileum is the most common site involved. Often, the disease extends up to include the ileocecal valve, and the most common approach is bowel resection extending from the proximal extent of the disease in the ileum to the ascending colon, which is usually uninvolved. Bowel continuity is restored with a primary anastomosis.

Colonic disease is traditionally regarded as being more aggressive, and the colon is not necessary for the nutritional function of the intestinal tract; therefore, some advocate subtotal colectomy rather than segmental resections when colonic involvement requires surgical intervention. However, segmental resection offers the opportunity to preserve colonic function and to avoid or delay the potential for permanent ileostomy.[26] Fewer symptoms, fewer loose stools, and better anorectal function have been reported following segmental resection, and the reresection rate did not differ from patients undergoing subtotal colectomy.[35,36]

In elective cases, entero–entero fistulas and enterocutaneous fistulas encountered during surgery are typically well formed, and careful review of preoperative imaging may facilitate identification in the operating room. Repair involves division of the fistula with repair of the normal structure.

Involvement of the urinary tract occurs in 4 to 35% of adult patients with Crohn's disease.[37] Fistula to the urinary tract with recurrent urinary infections may not constitute an urgent indication for operation, but continued soiling of the urinary tract could result in progressive renal dysfunction arguing for earlier rather than later intervention in these situations. Although some patients will respond to medical therapy, the vast majority of patients will require surgical intervention.[38–41] Enterovesical fistulas are treated with takedown of the fistula and closure of the bladder, whereas ureteral fistulas may require resection with reanastomosis or reimplantation of the ureter.

Regardless of the indication, the philosophy of therapy remains the same. The surgical procedure must be tailored to the individual patient, with an eye toward preserving all possible small bowel length while providing the most effective palliation of the presenting complication of the Crohn's disease. However, it is clear that surgical intervention is effective in relieving symptoms in patients with progressive or chronic stricturing or fistulizing disease as evidenced by reduced absence from school and improved overall well-being when compared with nonoperative therapy.[42]

Operative Emergencies

Patients who develop either perforation with diffuse peritonitis or obstruction that is unresponsive to medical management are rare but they may require an urgent operation. The operative goal in this situation is to control sepsis and to decompress the intestine with as little risk to the patient as possible. The

peritoneal cavity may be very hostile with inflammatory adhesions, fistulas, friable bowel, and diffuse peritonitis that make any extensive dissection ill-advised, and the most prudent approach is to divert the fecal steam with a proximal ostomy.[43] Resection of the involved segment may or may not be possible, and occasionally a proximal diversion is necessary without addressing the actual diseased bowel. In other cases, the perforated or obstructed segment can be resected, but sepsis or damaged bowel can make a primary anastomosis unsafe. Permanent ileostomy is uncommon in the pediatric patient, although the risk of permanent ileostomy is significantly increased in patients with rectal stricture and colonic disease.[44] Ileostomies are associated with significant complications along with a perceived negative social stigmata;[45] therefore, efforts to avoid them when safe for the patient are worthwhile. If a stoma is required to control intra-abdominal sepsis, the inflammatory adhesions are allowed to resolve for 6 to 8 weeks before a more definitive procedure with ostomy closure can be considered. Although no one, especially teenagers and their parents, wants an ileostomy, attempting an extensive dissection or bowel anastomosis in the face of severe inflammation can result in the loss of large segments of small bowel, which is more detrimental in the long run.

Similarly, patients with a Crohn's-related complete bowel obstruction that does not respond to medical therapy requires surgical intervention.[46] In patients without evidence of abdominal sepsis or bowel compromise, medical management may allow complete obstruction to resolve and should be attempted prior to surgery. This is especially true in cases involving difficult areas to treat surgically such as the duodenum, where avoiding surgical intervention is desirable.[47] If the obstruction fails to resolve or evidence of bowel compromise is present, operation must be undertaken without the ability to prepare the bowel for primary anastomosis. At surgery, the bowel is often inflamed and friable, and although a definitive resection with reanastomosis may be possible, the patient and family must be prepared for a temporary diverting ostomy to avoid the risks of a bowel anastomosis. Temporary ileostomy with subsequent closure avoids the risk of an anastomotic leak with potentially devastating complications.

Patients who have had multiple previous abdominal operations may be particularly challenging because of preexisting adhesions and scar tissue. Studies suggest that as many as half of the patients undergoing reoperative surgery will require ileostomy formation.[48] In many pediatric patients, this is less of an issue because often patients are making their first trip to the operating room, but one should never hesitate to perform a temporary bowel diversion when primary anastomosis may be unsafe.

Operative Technique

In an effort to preserve as much bowel length as possible, only gross disease is resected since recurrent disease may require additional surgery, which is particularly true in the pediatric population. In addition, bowel length may be shorter than normal in patients with Crohn's disease, leaving less margin for resection before developing issues with poor absorption.[49] The actual technical aspects of the procedure vary somewhat by surgeon and are largely a matter of training and experience. Bowel resection is performed in the standard fashion with no need to obtain clear margins or mesenteric lymph nodes as might be required for a cancer operation. Reestablishing intestinal continuity can be accomplished in several different ways. However, there is some evidence to suggest that a stapled side-to-side, functional end-to-end anastomosis may prolong the time to recurrence in patients with Crohn's disease.[50–58] The reason for this is unclear and may have to do with the diameter of the resulting anastomosis or the nonreactive nature of the staples. Alternatively, it may have more to do with the anatomic orientation of the anastomosis rather than the manner in which the bowel is reapproximated.[59] Anastomotic leaks and intra-abdominal abscesses are also less common with the stapled anastomosis in some series but not in others.[54,60–62]

Complications following bowel resection and anastomosis in Crohn's patients are common and are most often infectious in nature. Wound infections are most common and occur in as many as 20% of patients. The more serious complication of a leak at the intestinal anastomosis occurs in 3 to 10%.[54,63] Wound complications are treated with local care, whereas anastomotic complications may require reoperation with revision or temporary diversion with an ostomy.

Stricturoplasty

Diffuse small bowel disease with skip lesions or strictures that do not involve the ileocecal valve allows for some additional options in surgical treatment. Short segments are often resected with primary anastomosis when it represents the only area of disease. However, multiple short segments or longer segments up to 20 cm in length may be amenable to stricturoplasty rather than resection in an effort to preserve bowel length. Stricturoplasty is a relatively uncommon procedure in children, representing only a handful of cases in large series. Results from a small study comparing stricturoplasty to intestinal resection in pediatric patients showed no significant difference in relapse rate or complications.[64]

The technique entails a longitudinal enterotomy through the strictured segment with closure in a transverse fashion to relieve the obstruction (Heineke–Mikulicz stricturoplasty). The results following this operation are quite good even when applied to multiple strictures in the same patient.[65] Surprisingly, the rate at which recurrent disease occurs at the stricturoplasty site is low,[66] and the technique has been used for many years with results from long-term follow-up studies supporting its use.[67] Recurrence rates following stricturoplasty are on the order of 15% at 2 years and 20% at 5 years in adults.[68]

Laparoscopy

Minimally invasive surgical techniques including standard laparoscopy, single site surgery, and robotics have all been applied to the treatment of Crohn's disease. As with many of the other conditions to which laparoscopic techniques have been applied, multiple studies have demonstrated a decrease in hospital length of stay, more rapid return to work, less

postoperative narcotic use, and improved cosmetic results. Similarly, multiple studies of laparoscopic techniques applied to surgery for Crohn's disease in children and adults have also suggested shorter hospital stays, decreased need for parenteral narcotics, and faster return to a regular diet.[69–78] However, a recent Cochrane analysis has shown no difference in length of stay or duration of ileus,[79] and the morbidity of the laparoscopic approach is equivalent to open surgery.[80] Thus, although the benefits of the laparoscopic approach may be limited to improved cosmesis at the expense of longer operating time, there is a trend toward increased use of minimally invasive techniques, and the outcomes are at least equivalent to open surgery.

The techniques employed often use laparoscopic exploration of the abdomen with mobilization of the diseased bowel segment. Various sealer/cutting devices facilitate taking the mesentery of involved segments without additional blood loss and stapling devices allow for dividing the bowel at the margins of disease. Anastomosis may be performed extracorporeally after the diseased segment is delivered from the abdomen through a small incision or intracorporeally using the laparoscopic stapling devices. These techniques can also be incorporated into the single site surgical approach to achieve "scarless" operations,[81] although the benefit is purely cosmetic and the outcomes have not been tested.

Although complicated disease involving fistulas or phlegmon was considered a relative contraindication to the laparoscopic approach, many cases are now handled by experienced surgeons without an increase in complication rate.[82–87] One potential benefit of the laparoscopic approach is a reduction in postoperative adhesion formation. This carries added importance in the pediatric Crohn's populations where disease recurrence is common and reoperation is often necessary. Reduced adhesions facilitate subsequent operations[88] and theoretically lower the risk of injury to the bowel and ureters. Approaching recurrent disease laparoscopically without an increased complication rate is also feasible.[89,90]

In the long run, patients' quality of life does not appear to be impacted by the technique used at the time of surgery.[90,91] However, the advantage of the minimally invasive approach likely extends beyond quality of life measurements. Reduced intra-abdominal adhesion formation, possible faster resumption of full enteral nutrition, and perhaps less psychological trauma related to body image issues are all of particular significance to the pediatric patient population.

Perineal Disease

Medical therapy for perineal disease has been greatly improved with the advent of biological agents, yet more than half ultimately require surgical procedures.[92] Two controlled trials support the efficacy of IFX in achieving closure of perineal fistulas,[93] and the combination of IFX and surgical treatment of fistulizing perineal disease can result in marked improvement of perineal disease, which is superior to IFX alone.[94–96] Conversely, IFX treatment does not prevent the need for surgery for fistulizing Crohn's disease.[97]

Treatment algorithms in several pediatric IBD centers have evolved to include an aggressive surgical approach early. Examination under anesthesia is particularly useful in the pediatric population. A comprehensive evaluation by both surgeon and gastroenterologist in the operating room will allow a complete rectal examination along with endoscopy providing significantly more information than can be obtained at the bedside in younger patients who are unable to cooperate fully with the examination. The operating room environment allows one to carefully evaluate the extent of disease with delineation of fistula tracts, abscesses, and rectal strictures. Fistulotomies, seton placement, and drainage of superficial abscesses can all be accomplished with minimal trauma to the child. A complete assessment of the extent of the disease is important to help guide medical therapy.

Rectal Strictures

Low rectal and anal strictures caused by chronic fibrosis from chronic inflammation can be successfully treated with transanal dilations.[93] Younger pediatric patients may require dilations under anesthesia on a regular basis, whereas older patients will tolerate dilations in the office or at home. Incontinence can result from overdilation of rectal strictures or operative damage to the muscles during fistulotomy, but it is often difficult to separate the impact of the dilations relative to the underlying disease process. Tight irregular strictures longer than 3 to 4 cm without a clear lumen are a relative contraindication to dilation because perforation of the rectum is possible, particularly in small pediatric patients. Dilation in the operating room using balloon dilators guided by endoscopy or fluoroscopy may be necessary. Treatment with dilations may be needed for many months, and ultimately the result is dependent on systemic control of the disease process. Strictures that do not respond to chronic dilations may eventually require a diverting colostomy. Transanal resection of a rectal stricture has been reported.[98] The combination of anal stricture and colonic Crohn's disease ultimately leads to fecal diversion in more than 50% of patients.[99]

Postoperative Recurrence

Recurrence of Crohn's disease following a surgical resection is common. In many cases, medical therapy is discontinued following surgical treatment, but continued therapy with several drugs has been investigated to improve disease-free intervals. Establishing the recurrence risk for individual patients and performing endoscopic surveillance are important to help guide therapy.[100] While some studies fail to demonstrate an advantage to prophylactic therapy,[101] others have proposed specific algorithms for follow-up and treatment.[102,103] Agents including the 5-aminosalicylate formulations, antibiotics, steroids, and azathioprine have been examined. None of these therapies has convincingly been shown to prevent recurrent lesions.[104] IFX has been reported effective in a prospective randomized trial where remission was maintained in 93% of patients in the IFX group and in only 53% of patients in the control group.[105] Importantly,

early postoperative treatment with IFX does not appear to be associated with an increase in adverse events.[100] The antibiotics metronidazole and ornidazole have shown efficacy but cannot be used in the long-term because of its side effects.[106] 6-Mercaptopurine and azathioprine may be more effective than mesalamine.[93,107,108]

Given the risk of recurrent disease, it is important to resect only the grossly involved segment of intestine at the time of the initial operation. Fortunately, there is some evidence to suggest that the involved segments of intestine in subsequent operations for ileal disease are shorter than those involved at initial presentation.[109]

Conclusion

Fortunately, surgical treatments have evolved along with medical therapy, and current surgical procedures are safer and less invasive than at any time in the past. Surgery has progressed from a treatment of last resort for life-threatening complications to therapy for use in conjunction with medical interventions to maximize the patient's quality of life. While the specter of short bowel syndrome must be kept in mind, elective procedures to treat the complications of Crohn's disease can be accomplished safely and effectively.[110] Despite this, surgical treatment carried a 22% complication rate and a 15% recurrence rate, and 21% of patients had an unplanned return to the operating room in a recent study.[111] While medical therapy may one day render surgical therapy unnecessary, at present, the surgeon remains an integral part of the treatment team for patients with any IBD, and Crohn's disease in particular.

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